

Feasability study of GMSB final state with taus and missing ET

Anne-Catherine Le Bihan / Francois Charles

SUSY framework

Signal and topology

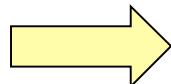
Background

Expected results

SUSY signal

- GMSB model with stau NLSP : $\square, M_{mess}, nq, nl, \tan \beta, \text{sign}(\mu)$
- Prompt stau decay :

Stau \rightarrow tau + gravitino



Choose $\sqrt{F} = \square^* M_{mess}$, equivalent to $C_{grav}=1$

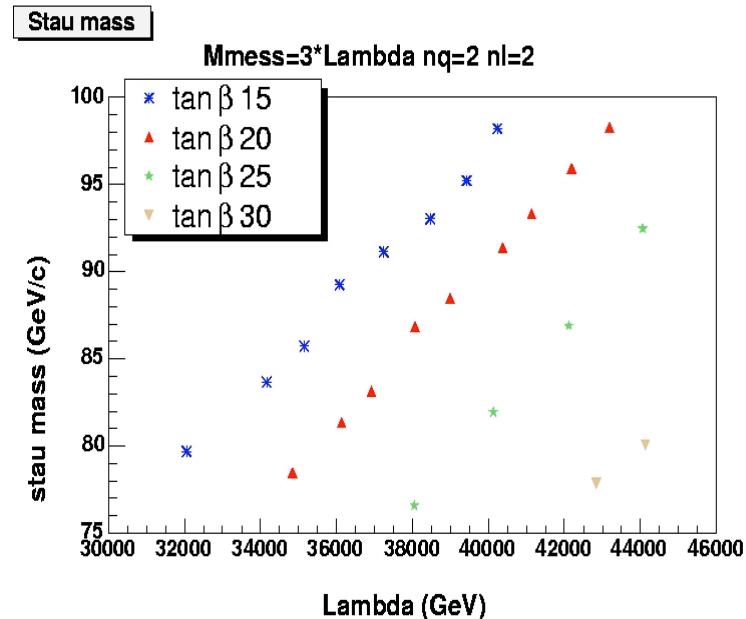
Dominant production cross sections are $\square_1^\pm \square_1^\pm, \square_1^\pm \square_2^0, \square_1^\pm \square_1^0$

Final state : 2 LSP decays : 2 taus + missing ET and additional taus and leptons from the cascade

Preliminary study with SUSYGEN

- Susygen uses SUSPECT for RGE evolution
- three body decay of $\tilde{\chi}_1^0 \rightarrow \tau + \text{stau}$ described / not present in pythia

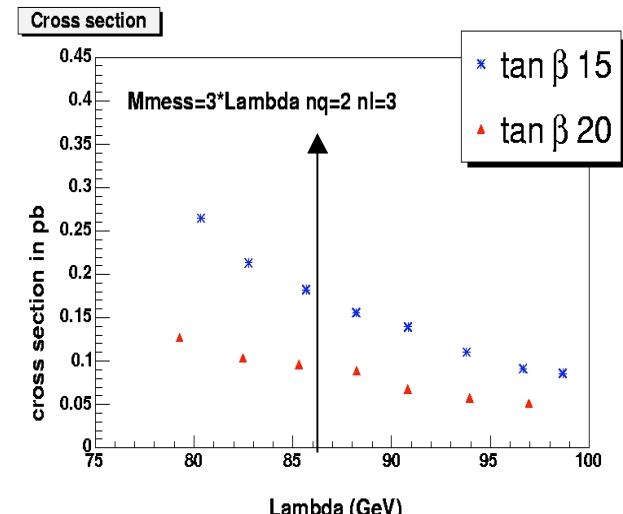
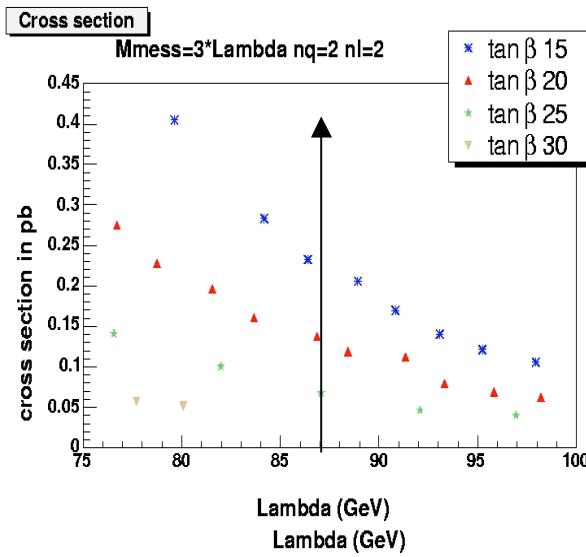
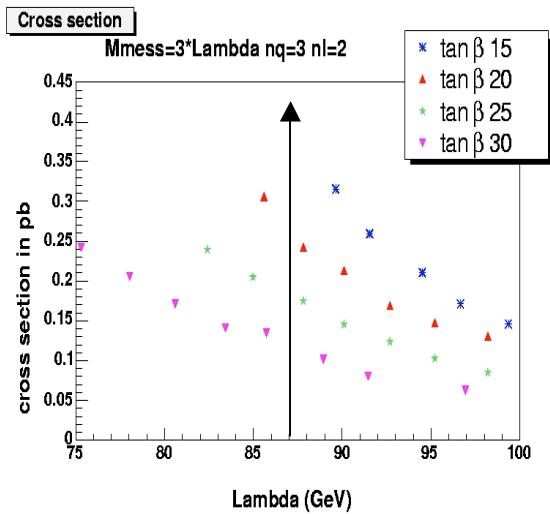
- Scan in the GMSB parameter space :
- $M_{\text{mess}} = 3 * \tilde{\chi}$
- $\tilde{\chi} : 30000 - 45000 \text{ GeV}$
- $\tan \beta : 10 - 30 \text{ step of } 5$
- $nq, nl : 2, 3 / 3, 2 / 2, 2$
- Sign $\tilde{\chi} = +1$



TMBTrees processed with p14.05.02 and v03 of d0correct/tmb_analyze

Expected cross sections

Cross sections depend on stau mass, $\tan(\beta)$ and nq and nl values :



Look at : $nq=nl=2 \tan\beta=15,20 \rightarrow 35000$

$nq=2 nl=3 \tan\beta=15 \rightarrow 35000$

$nq=3 nl=2 \tan\beta=15 \rightarrow 29000, \tan\beta=20 \rightarrow 31000$

Branching ratios

Tau multiplicity of the event can be enhanced by direct decays of neutralinos and charginos in stau or stau + tau.

$\tilde{\tau}_2^0$ BR in stau + tau : [30-60 %]

$\tilde{\tau}_1^0$ BR in stau + tau :

100 % for $nq, nl = 2$

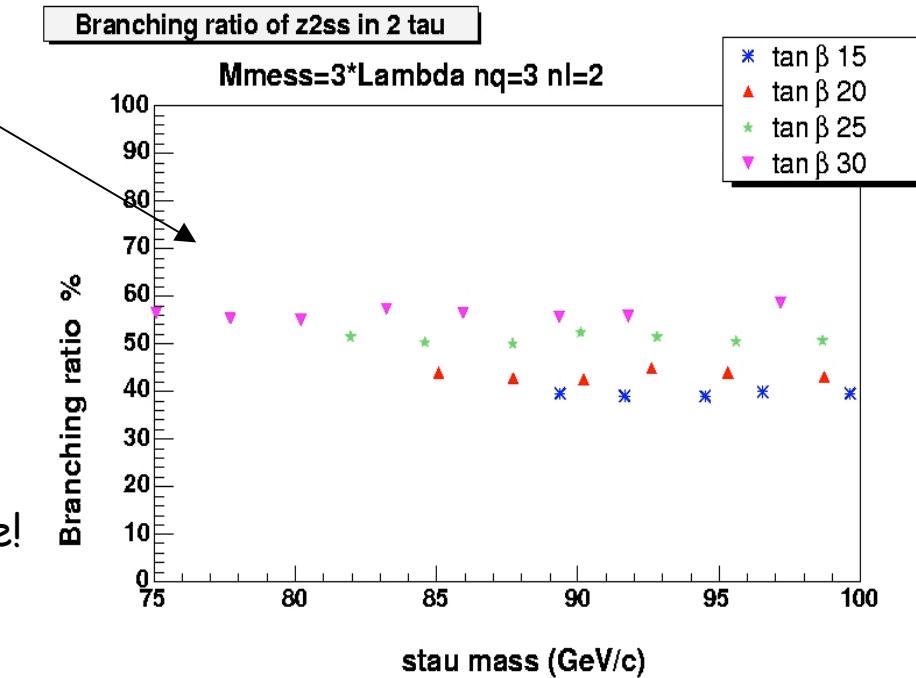
> 70 % for $nq=2, nl=3$ or $nq=3, nl=2$

$\tilde{\tau}_1^{+}$ BR in stau : [0-30 %] for $nq=nl=2$

and $nq=2, nl=3$

-> additional leptons from the cascade!

$\tilde{\tau}_1^{+}$ BR in stau > 60 % for $nq=3 nl=2$



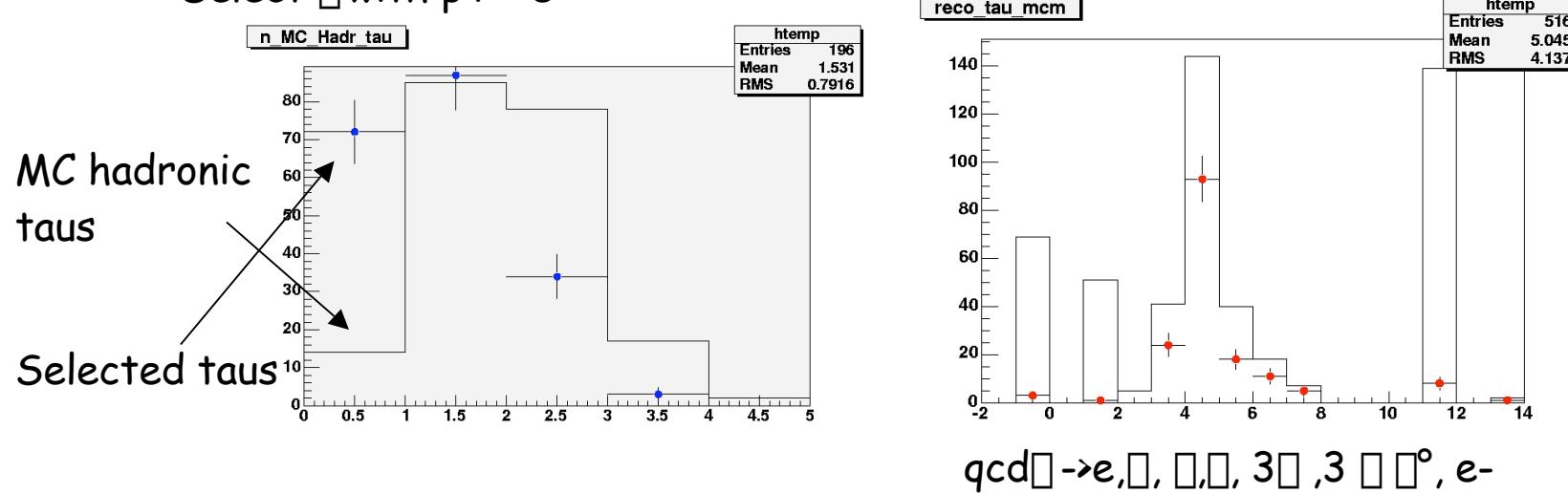
Event selection (I) - tau ID

Use «Beaune» version of Neural networks for tau identification :

Apply cut on maximal value of the of 3 NN

Define 3 quality cuts : - tight/medium/loose : maxNN >0.95 / >0.9 / >0.8

- Select τ with $pT > 8$



Try to further remove electron contamination by applying a second NN (trained on $Z \rightarrow ee$ background) on tau candidates with one track and EM cluster
Expect ~60 % efficiency for susy pT spectrum

Event selection (II)

«**Lepton Id** » :

- Look for «medium» muons with $pT > 10 \text{ GeV}$ - p14 certification
- select isolated muons with E_{Halo} cut of 3 GeV
- Look for electron candidates with $pT > 15 \text{ GeV}$ - $|Id| = 11$, $H_{\text{max}} < 20$, $\text{iso} < 0.15$, $\text{emfrac} > 0.9$

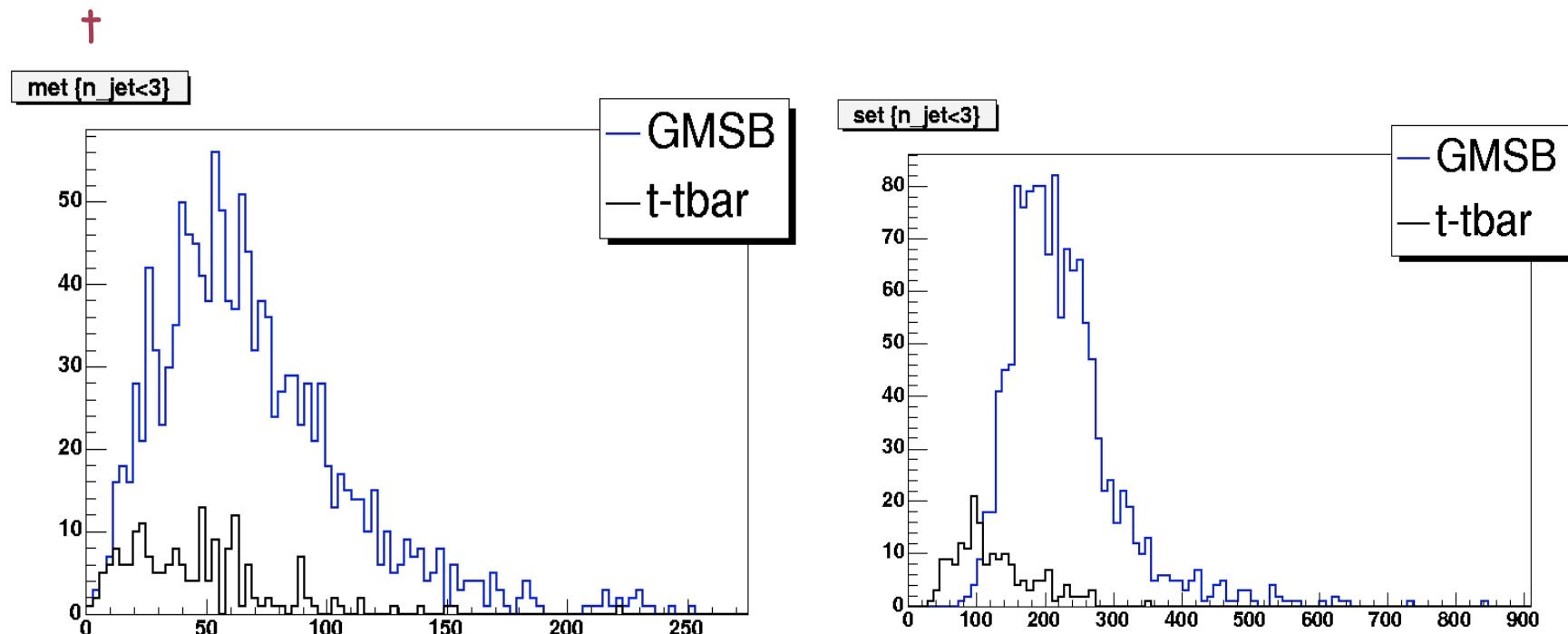
«**Jet Id** » :

- veto on events with $n_{\text{jet}} > 2$ after removing identified taus in a 0.3 cone

«**topological cuts** » : $|M_{\mu\mu}-91| > 10$, $|M_{ee}-91| > 10$, $|M_{e\mu}-91| > 10$
 $|\phi(\mu\mu)| < 2.6$, $|\phi(ee)| < 2.6$, $|\phi(e\mu)| < 2.6$

→ Remove Z contamination

Met, Set



Signal Efficiencies for different topologies

$\Box = 40 \text{ TeV}$			
$\tan \Box = 15 \quad nq=2 \quad nl=2$			
$\Box = 0.1 \text{ pb}$			
$\Box = 34 \text{ TeV}$			
$\tan \Box = 15 \quad nq=2 \quad nl=3$			
$\Box = 0.18 \text{ pb}$			
$\Box = 31 \text{ TeV}$			
$\tan \Box = 15 \quad nq=3 \quad nl=2$			
$\Box = 0.28 \text{ pb}$			

		$\text{met} > 20 \text{ GeV}$	$\text{set} > 80$	$n\text{jet} < 3$	$+ \text{topological cuts}$	Events in 500 pb^{-1}
1 tau lep > 1	14 %	5.5 %				2
2 tau lep $>= 1$	11.5 %	5.5 %				2
1 tau lep > 1	9 %	6 %				5
2 tau lep $>= 1$	9 %	1.5 %				1
1 tau lep > 1	3.5 %	1.5 %				2
2 tau lep $>= 1$	9 %	3.5 %				5

t-tbar Background

t-tbar : $\square = 8 \text{ pb}$

Use JLIP b-tagging method to further reduce the ttbar background, apply a cut on jet proba < 0.01 : 1% background - 60 % efficiency on MC

		Met>20 set>80 njet<3 + topological cuts	after veto on b-tagged events	Events in 500 pb -1
1 tau lep>1	0.66 %	0.55 %	0.02 %	~ 1
2 tau lep>=1	0.9 %	0.2 %	0.08 %	~3

W/Z + jets background (preliminary)

$Z \rightarrow \ell\ell$	
$60 < m < 130$	
$Z \rightarrow ee$	
$60 < m < 130$	
$Z \rightarrow \ell\ell$	
$60 < m < 130$	
$W + \text{jet}$	
$W + 2\text{jet}$	
$W + 3\text{jet}$	

		$\text{met} > 20 \text{ GeV}$ $\text{njet} < 3 +$ topological cuts	Events in 500 pb ⁻¹
1 tau lep >1	6 %	0.01 %	9
2 tau lep ≥ 1	3 %	0.05 %	46
1 tau lep >1	4 %	0.03 %	27
2 tau lep ≥ 1	3.5 %	0.03 %	27
1 tau lep >1	1.6 %	0.04 %	36
2 tau lep ≥ 1	0.1 %	0.01 %	9
1 tau lep >1	0.05 %	0.02 %	67
2 tau lep ≥ 1	0.025 %	0.02 %	67
1 tau lep >1	0.04 %	0 %	0
2 tau lep ≥ 1	0.17 %	0.09 %	99
1 tau lep >1	0.09 %	0.02 %	8
2 tau lep ≥ 1	0.3 %	0.11 %	41

Outlook

- Reduce W/Z + jets background, else analysis won't be feasible

If analysis feasible :

- Estimate efficiencies of NN on p14 data (check for differences with MC)

Try to reduce further electron and muon contamination

- Estimate trigger efficiencies
- Estimate QCD fake electrons
- Control missing Et
- Start to look at points below LEP limit